**a module solution provider**

# MM5D91-00

## 60GHz mmWave Radar

## Presence Detection Sensor Module

## Datasheet

## Revision 1.0

| Prepared By | Reviewed By | Approved By |
|---|---|---|
| | | |

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## 1. INTRODUCTION

The MM5D91-00 is the presence detection sensor module which integrates 60GHz mmWave technology. The module simplifies the implementation of mmWave sensors in the band of 61.0 to 61.5GHz, and it includes the ARM Cortex-M4F based processor system, 1Tx 3Rx antenna and onboard regulator. This presence detection sensor module targets low power and high resolution presence detection in smart home, office, security and diverse applications.

### 1.1. General Features

- ARM Cortex-M4F 150MHz, 1024KB Flash, 288KB RAM
- Built-in Antenna (1Tx, 3Rx)
- Built-in Regulator
- UART interface and GPIOs
- 3.6~5.5V Power input
- 26pin pitch 1.27mm Castellated Holes
- Dimensions: 20 x 15 x 2.3 mm

### 1.2. Presence Detection Features

- Presence sensing for home, office and commercial buildings
- Adjustable detection range
- Field of View of Radar : Azimuth: ± 45° / Elevation: ± 40°
- Supported moving object speed (m/sec): up to 2.0 m/sec
- Static objects (non-living) are not detected
- Able to detect presence (≤1sec) when at least one moving object is present
- Absence is declared in around 3sec (both macro and micro modes enabled). Configurable up to 30sec
- Detection Range :

  ※ Detection up to 10m for macro motion [1]
  ※ Detection up to 5m for micro motion [2]

  (1)  Macro motion: human movements
  (2)  Micro motion:
       Stationary human (normally breathing and blinking eyes) in sitting or standing positions with no active movements for at least 30 sec.
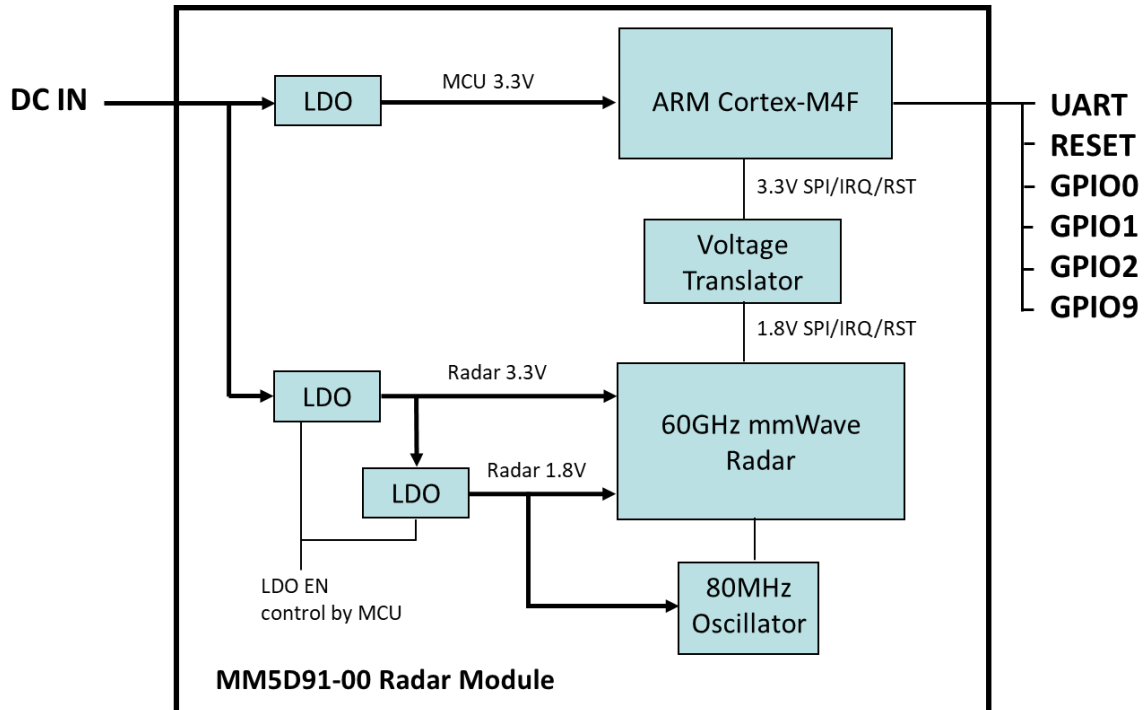
## 2. HARDWARE INFORMATION

### 2.1. Block Diagram



**Figure 2-1. MM5D91-00 Block Diagram**
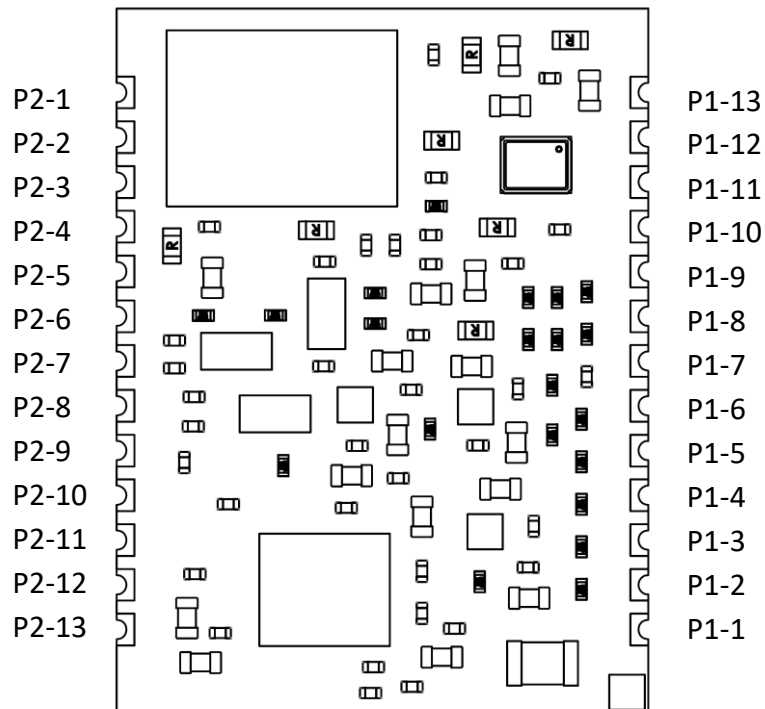
## 2.2. Module Pin Define



**Figure 2-2. MM5D91-00 Module View**

**P1 Pin define:**

| Pin No. | Signal Name | Description |
|---------|-------------|-------------|
| P1-1 | NC | No Used. |
| P1-2 | NC | No Used. |
| P1-3 | NC | No Used. |
| P1-4 | NC | No Used. |
| P1-5 | NC | No Used. |
| P1-6 | NC | No Used. |
| P1-7 | NC | No Used. |
| P1-8 | nRESET | Reset for radar module. Internal pull high default. |
| P1-9 | UART_TX | UART Transmit. Reserve test point for firmware upgrade. |
| P1-10 | UART_RX | UART Receive. Reserve test point for firmware upgrade. |
| P1-11 | NC | No Used. |
| P1-12 | NC | No Used. |
| P1-13 | GND | Ground. |

**P2 Pin define:**

| Pin No. | Signal Name | Description |
|---|---|---|
| P2-1 | NC | No Used. |
| P2-2 | NC | No Used. |
| P2-3 | GPIO0 | GPIO0. Default low, green color for presence indication. |
| P2-4 | GPIO1 | GPIO1. Default low, red color for not presence indication. |
| P2-5 | GPIO2 | GPIO2. Default low, blue color for bootloader mode indication. |
| P2-6 | NC | No Used. |
| P2-7 | NC | No Used. |
| P2-8 | NC | No Used. |
| P2-9 | NC | No Used. |
| P2-10 | NC | No Used. |
| P2-11 | NC | No Used. |
| P2-12 | GPIO9 | GPIO9. Please Pull high 1K ohm to VIO. |
| P2-13 | DC_IN | Power supply input. Range from 3.6V to 5.5V. |

## 2.3.  Recommended Operating

| Parameter | | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| DC_IN | DC supply input | 3.6 | | 5.5 | V |
| VIH | IO high-level input voltage | 2.3 | - | - | |
| VIL | IO low-level input voltage | - | - | 1 | |
| Current Consumption @ DC_IN=5V [1] | Presence detect mode on | | 12.0 | | mA |
| | Presence detect mode off | | 3.7 | | |
| | Deep sleep mode | | 0.04 | | |
| Phase noise | At 100KHz offset | | -80 | | dBc/Hz |
| Operating Temperature [2] | | -20 | | 70 | $^o$C |
| Storage Temperature | | -40 | | 85 | $^o$C |

(1)   Based on firmware 237a4fe version.

(2)   Means ambient temperature when working.

## 2.4.  Built-in Antenna Specifications

| Parameter | | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| RX_BW, TX_BW | Antenna bandwidth | 61.0 | | 61.5 | GHz |
| Output Power | EIRP | | +7.5 | | dBm |
| Antenna gain of single TX | | 2.0 | 3.5 | 5.0 | dBi |
| Antenna gain of single RX | | 2.0 | 3.5 | 5.0 | dBi |
| Field of View of Azimuth | | 70 | 90 | 110 | Deg |
| Field of View of Elevation | | 60 | 80 | 100 | Deg |

## 3. RADAR RADIATION PATTERN

### 3.1. Test Setup

**E-Plane**

-90° +90°

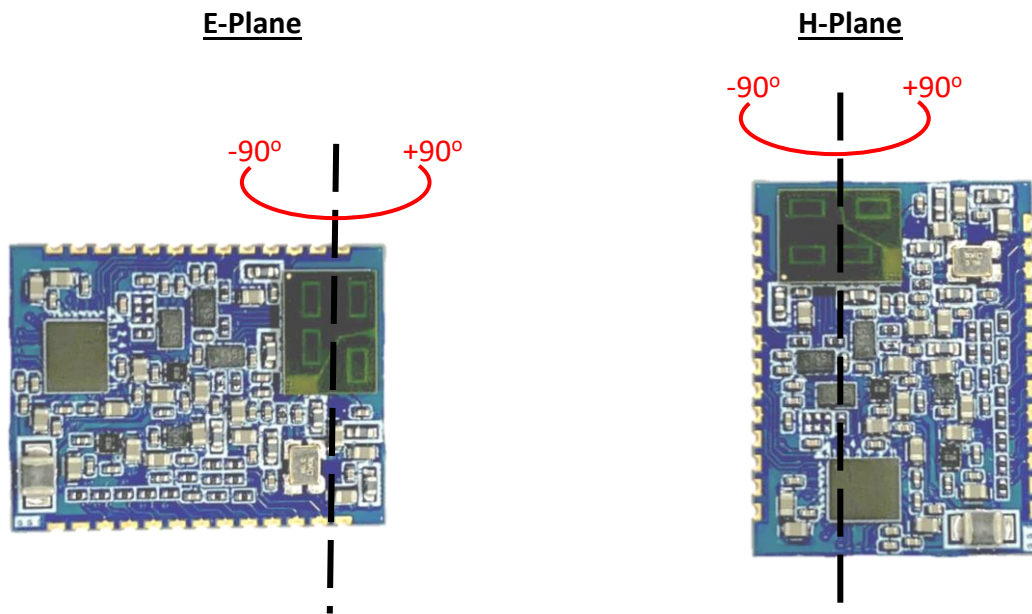**H-Plane**

-90° +90°

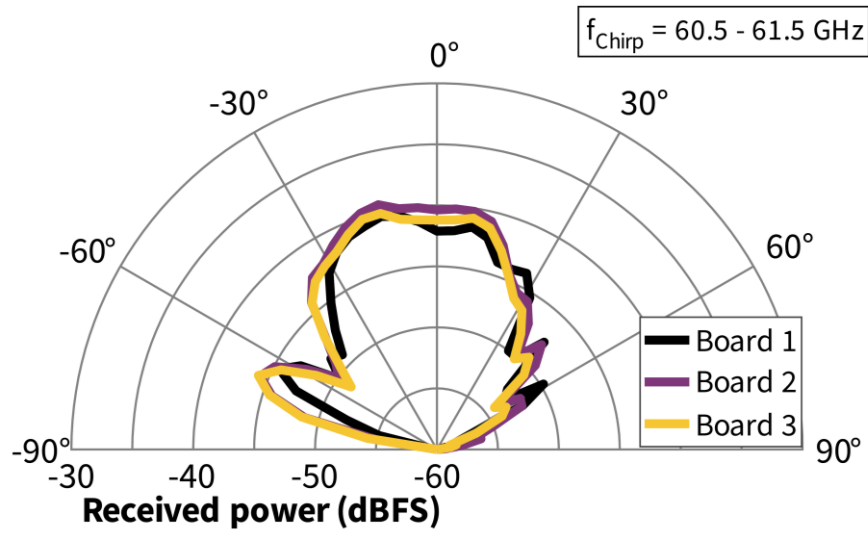**Figure 3-1. Antenna Setup**

## 3.2. Radio Pattern



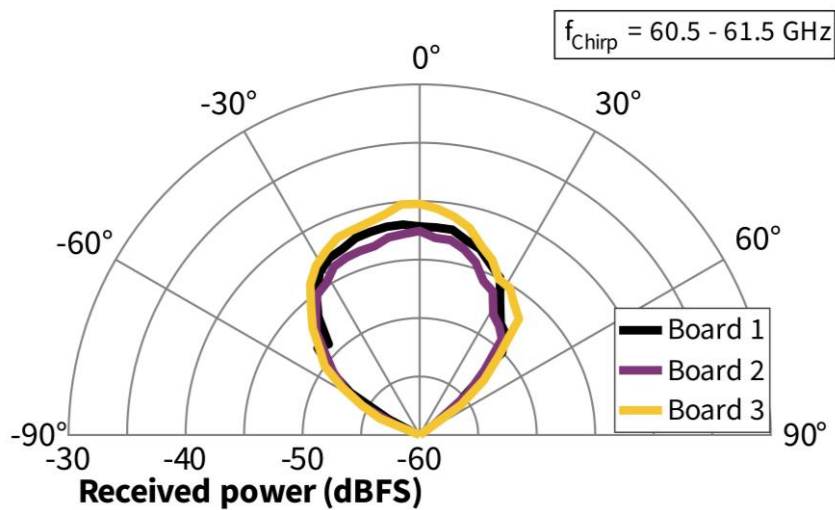**Figure 3-2. Radiation Pattern of the E-Plane**



**Figure 3-3. Radiation Pattern of the H-Plane**

## 4. EVALUATION KIT

The Jorjin mmWave Radar sensor evaluation kit MM5D91E00 show as below. Based on the MM5D91-00 Radar sensor module, evaluation board is built to demonstrate the function of presence detection of the 60 GHz radar sensor with its sophisticated radar presence detection algorithms. This evaluation kit easy to demo and development for customer.
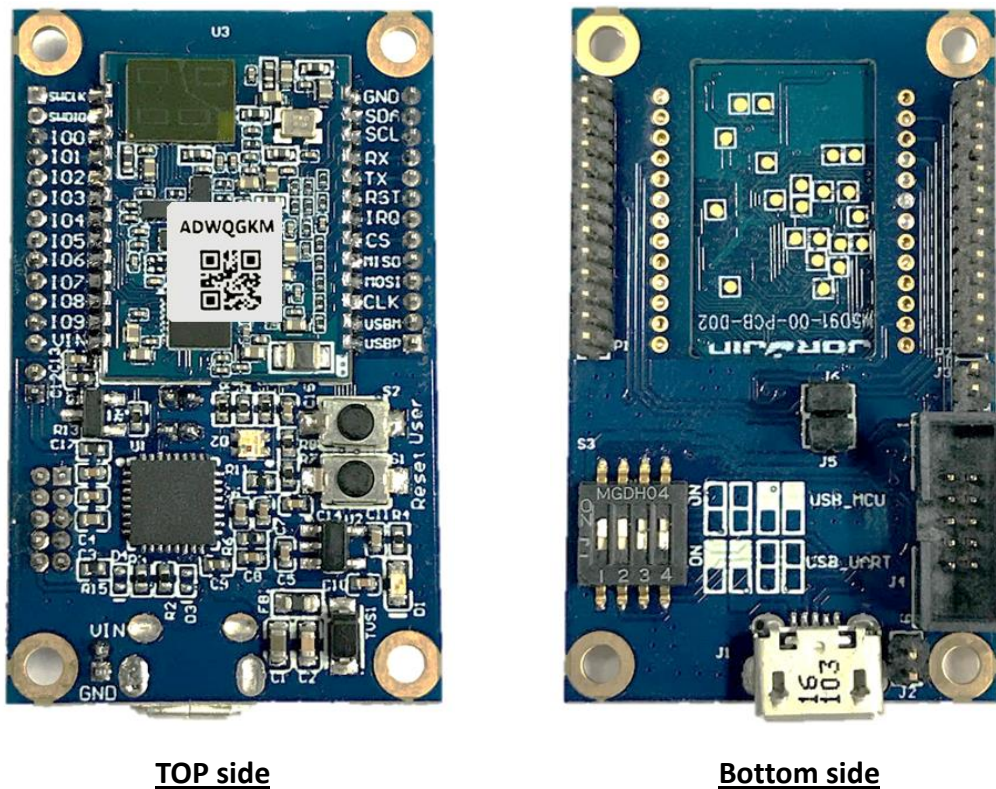


**TOP side**                                    **Bottom side**

**Figure 4-1. MM5D91E00 mmWave Radar Evaluation Kit**

## 4.1. Evaluation Hardware Description

The following figure and table describe physical sections of the board.
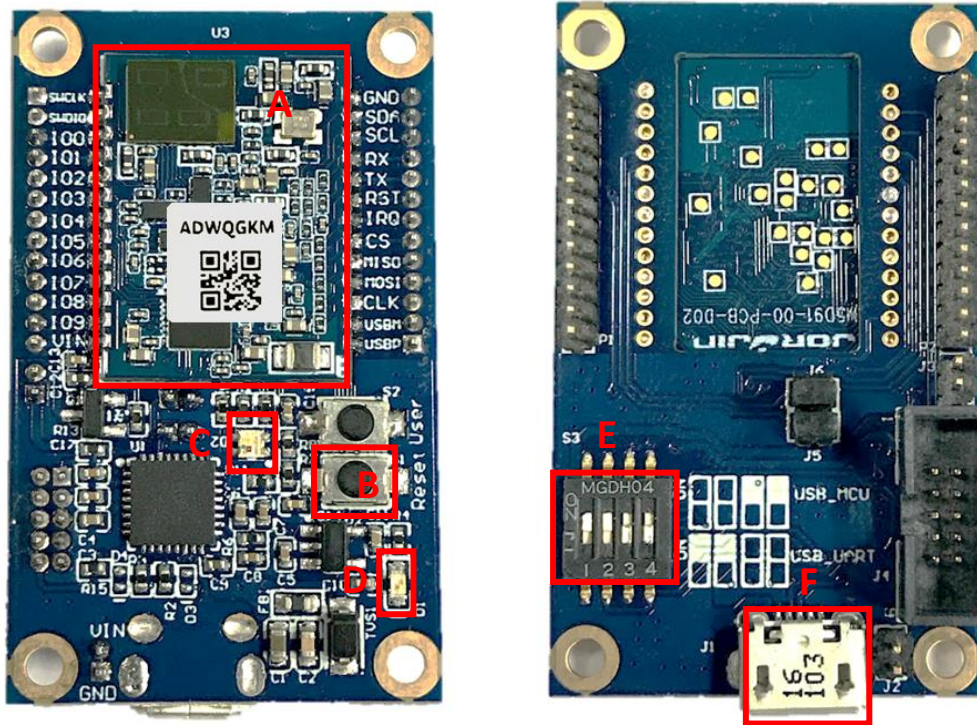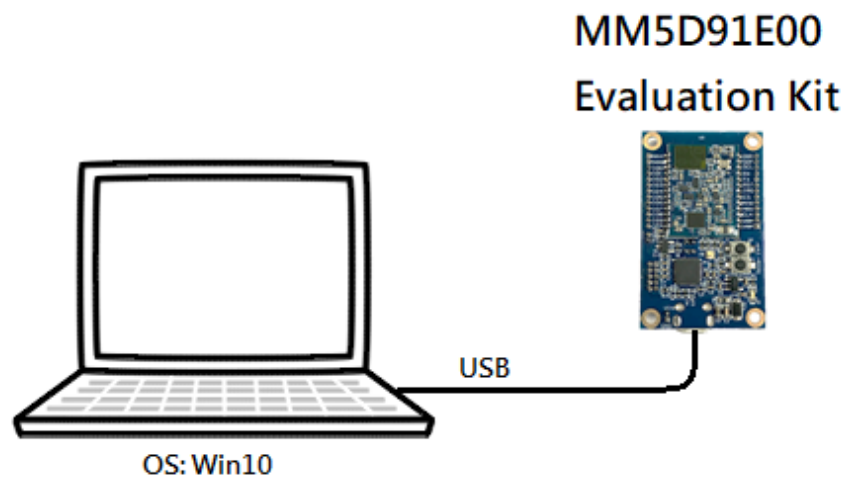


**Figure 4-1. Hardware description of Evaluation Kit**

**Table 4-1. Evaluation Kit component descriptions list**

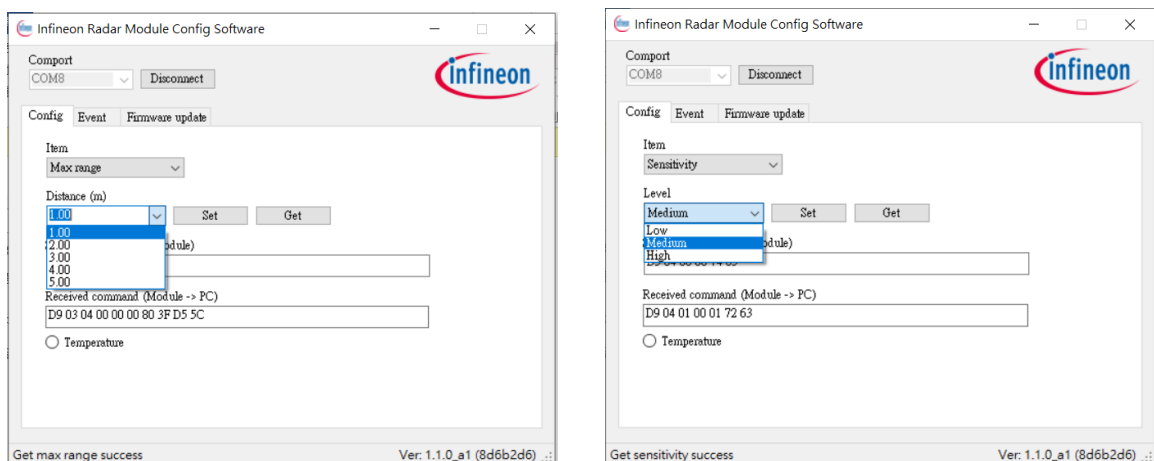| Region | Description |
|--------|-------------|
| A | Jorjin mmWave Radar sensor module. |
| B | Radar sensor module reset switch. |
| C | Red LED light when the evaluation kit is power on. |
| D | LED of radar detect status:<br>- Green color : No presence.<br>- Red color : Presence detected. |
| E | Interface setting: Turn up of left two / Turn down of right two.<br>Please keep the setting always. |
| F | Micro USB connector. Connected to PC (config tool) or power bank to demo. |

## 5. CONFIGURABILITY

- Easy Configuration UART port for the end user to change parameters

- Standard mode: Detection range, sensitivity, reset etc.

- Expert mode: macro/micro modes, thresholds etc.

- The detection range, sensitivity and status settings are stored in the flash and remain set after power reboot.



If the OS is win7 or lower , please find the USB driver as the link.

**Figure 5-1. Radar module connect to PC**



**Figure 5-2. Radar Module Configuration software**
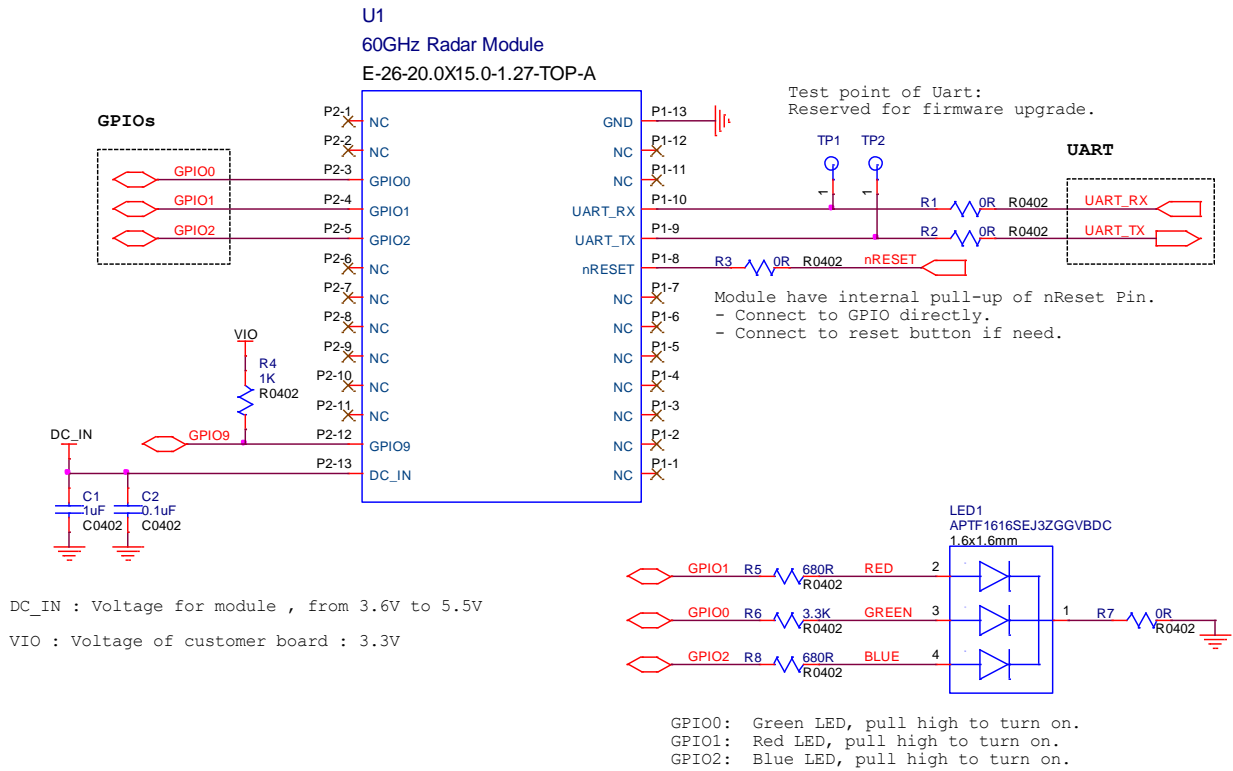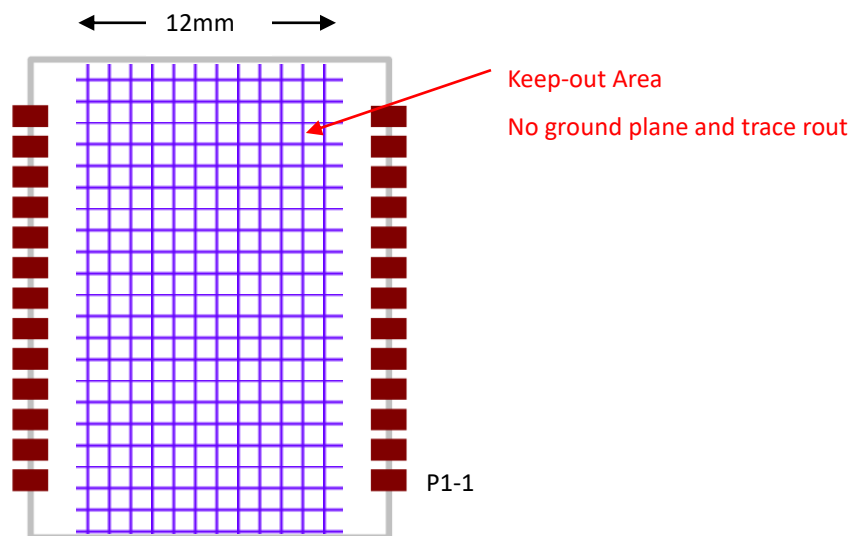
# 6. REFERENCE OF DESIGN

## 6.1. Reference Schematic



**Figure 6-1. MM5D91-00 Radar Module Reference Circuit**

## 6.2. Design Recommendation

1. Please reserve the test points of UART for firmware upgrade in the future.

2. Please keep the module solder layer that no ground plane and trace rout in the keep-out area. Show in Figure 6-2.

3. The power trace for DC_IN must be at least 20-mil wide.
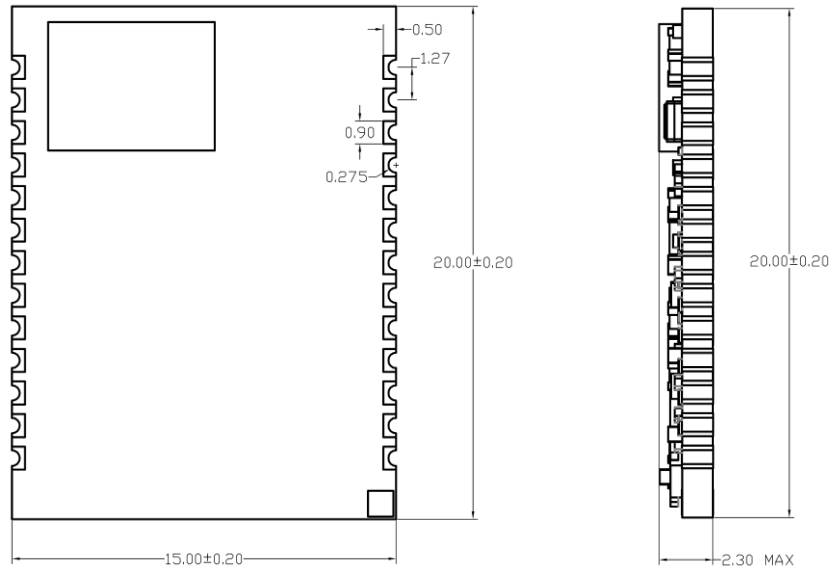


**Figure 6-2. Recommend Layout of Radar module**

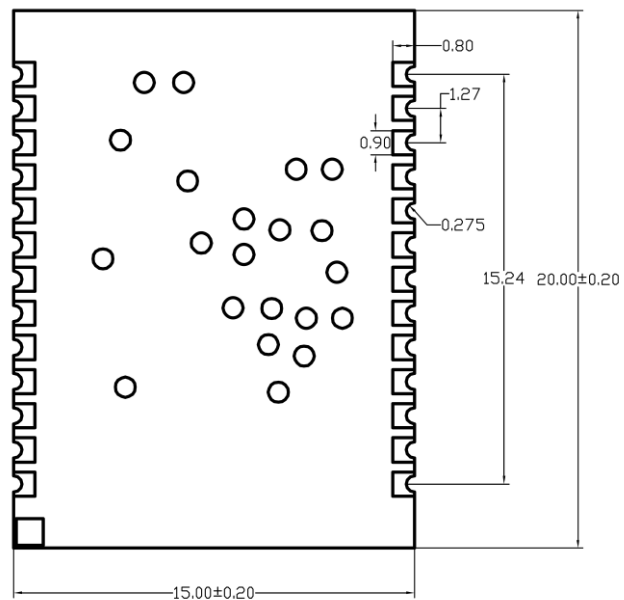## 7. PACKAGE INFORMATIION

### 7.1. Module Dimension



Top View                                    Side View



Bottom View

**Figure 7-1. MM5D91-00 Module Dimension**

## 7.2. Recommended Land Pattern



**Figure 7-2. Recommended Land Pattern Dimension**

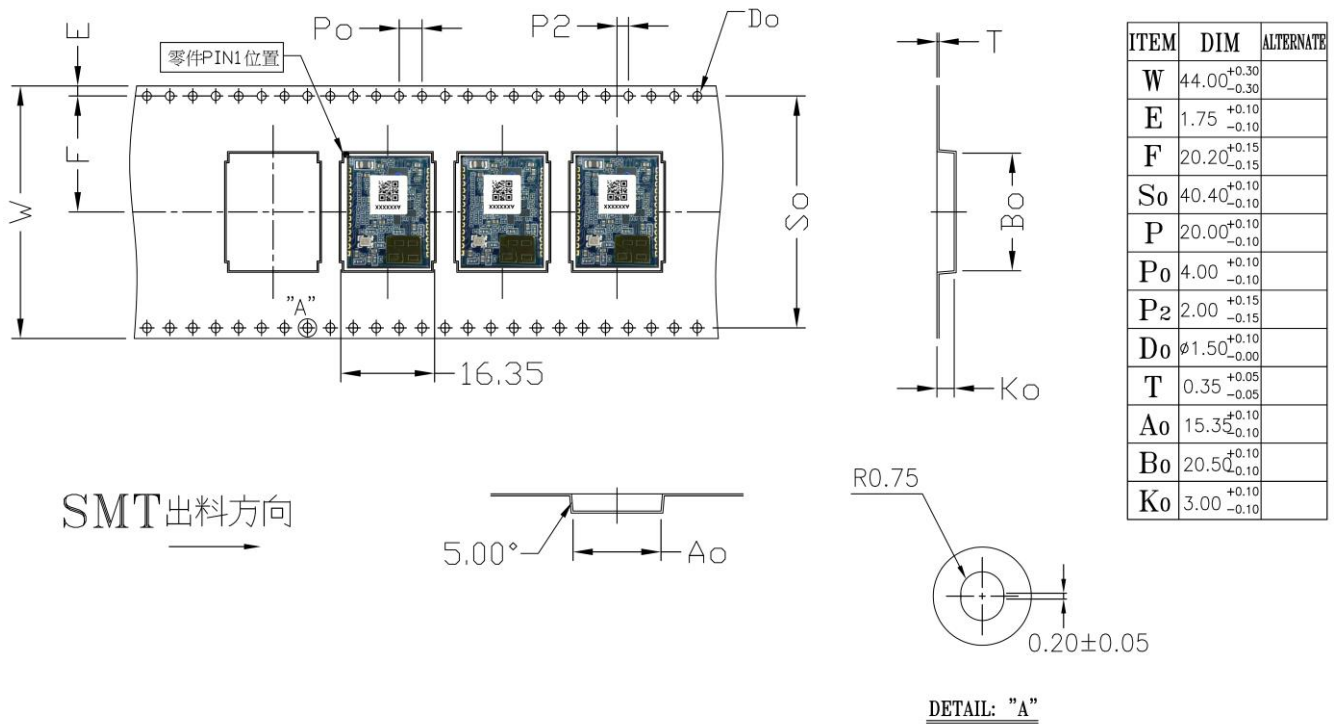## 7.3. Device Label



Pin 1

| Marking | Description |
|---|---|
| **QR Code :**<br><br>  YYWW,AXXXXXX | <br>YY : Digit of the year, ex: 2019=19<br><br>WW : Week (01~52)<br><br>A : Product Number, ex: A=MM5D91-00<br><br>XXXXXX : Series number. |

## 7.4.  Tape Reel information



| ITEM | DIM | ALTERNATE |
|------|-----|-----------|
| W | $44.00^{+0.30}_{-0.30}$ | |
| E | $1.75^{+0.10}_{-0.10}$ | |
| F | $20.20^{+0.15}_{-0.15}$ | |
| So | $40.40^{+0.10}_{-0.10}$ | |
| P | $20.00^{+0.10}_{-0.10}$ | |
| Po | $4.00^{+0.10}_{-0.10}$ | |
| P2 | $2.00^{+0.15}_{-0.15}$ | |
| Do | $\varnothing1.50^{+0.10}_{-0.00}$ | |
| T | $0.35^{+0.05}_{-0.05}$ | |
| Ao | $15.35^{+0.10}_{-0.10}$ | |
| Bo | $20.50^{+0.10}_{-0.10}$ | |
| Ko | $3.00^{+0.10}_{-0.10}$ | |



Reel : 1000 pcs per reel



Pizza Box : 1 reel per pizza box

## 8. SMT / BAKING INFORMATION

### 8.1. Baking Recommendation

Baking condition:

- Follow MSL Level 4 to do baking process.
- After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be
  a. Mounted within 72 hours of factory conditions <30°C / 60% RH
  b. Stored at <10% RH.
- Devices require bake, before mounting, if Humidity Indicator Card reads >10%
- If baking is required, Devices may be baked for 8 hrs at 125 °C.

### 8.2. SMT Recommendation

Recommended Reflow profile: